SECTION 8—INFORMATION SYSTEMS TECHNOLOGY

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OVERVIEW

Information Systems (IS) are defined as the entire infrastructure, organization, personnel and components that collect, process, store, transmit, display, disseminate and act on information. IS include several functional areas: acquisition, organization, and management of data; processing and manipulation of data; information storage and retrieval; human-system interfaces; and means for ensuring the reliability and security of information and system resources. Most technologies used in information systems are dual use. New technologies and products are emerging daily. Performance of processors and capacity of memory chips has doubled every 18 months since 1970. This exponential growth is expected to continue until the year 2005. In addition to technology for the hardware and software components of reliable and secure information systems, other technology, in the form of specialized know-how for system design and integration, is necessary to meet important military requirements for C^4I^2, intelligent systems, modeling and simulation, and strategically essential industrial CAD/CAM uses. Also, IS are the primary "enabler" and a target for Information Warfare (see Section 9). The technology areas listed in the box nearby contain militarily critical technologies.

SECTION 8.1—COMMAND, CONTROL, COMMUNICATIONS, COMPUTING, INTELLIGENCE, AND INFORMATION SYSTEMS (C^4I^2)

OVERVIEW

C^4I^2 comprises a multi-disciplined set of techniques to provide seamless communications, information management, and distribution, and decision-making in the new JCS Vision 20/0, improving situational awareness and effectiveness of warfighting forces in high-intensity combat situations. C^4I^2 is dependent on underlying hardware and software technologies covered elsewhere in this section. In addition, elements of C^4I^2 are also essential for development and operational integration of dynamic training, modeling, and simulation (see Fig. 8.1-1). Battlespace environment has been explicitly identified as one of DoD's key technology areas for C^4I^2 and encompasses the following as key elements: weather prediction; propagation sensor modeling and performance prediction; and the underlying information management and human interface technologies required for effective use. While primarily aimed at military situational awareness and dynamic training and combat simulation, the technologies in question will find widespread commercial use in entertainment, education, and science and engineering.

8.3	High Performance Computing
8.4	Human Systems Interface
8.5	Information Security
8.6	Intelligent Systems
8.7	Modeling and Simulation
8.8	Networks and Switching
8.9	Signal Processing
8.10	Software
8.11	Transmission Systems
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Figure 8.1-1. Primary Supporting Information Systems Technologies for Command, Control, Communications, Computing, Intelligence, and Information Systems (C^4I^2)

Table 8.1-1. Command, Control, Communications, Computing, Intelligence, and Information Systems (C^4I^2) Militarily Critical Technology Parameters

TECHNOLOGY	Militarily Critical Parameters Minimum Level to Assure US Superiority	Critical Materials	Unique Test, Production, and Inspection Equipment	Unique Software and Parameters	Control Regimes
SHORT TERM, NEAR REAL-TIME WEATHER PREDICTION, OCEANOGRAPHIC MODELING TO SUPPORT LITTORAL WARFARE AND OTHER ACTIVITY	4-hr turnaround of 72-hr weather prediction of dispersion patterns, rates of transport, and effective concentrations of aerosols, particles, or gases	None identified	None identified	Software characterizing the dispersion characteristics of aerosols and gases in realistic weather and terrain conditions	WA ML 17, 21

(Continued)

Table 8.1-1. Command, Control, Communications, Computing, Intelligence, and Information Systems (C^4I^2) Militarily Critical Technology Parameters (Continued)

TECHNOLOGY	Militarily Critical Parameters Minimum Level to Assure US Superiority	Critical Materials	Unique Test, Production, and Inspection Equipment	Unique Software and Parameters	Control Regimes
SENSOR MODELING AND PERFORMANCE PREDICTION	Validated performance of one or more operational or developmental military sensors under battlefield conditions	None identified	Anechoic chambers Other modeling support equipment	Software (operational and design models) characterizing clutter and interference effects and sensor response to same	WA ML 17, 21
VEHICLE MODELING TO PREDICT OFF-ROAD TRAFFICABILITY ACCURATELY	Validated off-road trafficability of operational or developmental military vehicles in one or more environmental scenarios	None identified	Empirically validated vehicle test facilities	Models and simulations of vehicle traction (for land vehicles) and dynamics	WA ML 17, 21
EM PROPAGATION CHARACTERIZATION TO PREDICT PERFORMANCE OF SENSORS, COMMUNICATIONS, AND ELECTRONIC AND LASER CM EFFECTS	Validated models of EM propagation in which military sensors or communication systems are exposed to two or more measured environmental effects	None identified	None identified	Software (operation and design models) characterizing propagation effects and sensor response to same	WA ML 17, 21

SECTION 8.2—COMPUTER-AIDED DESIGN AND COMPUTER-AIDED MANUFACTURING (CAD/CAM)

OVERVIEW

Computer-aided design (CAD) is a technology enabling the design of intricate and often complex devices, mechanisms, and/or systems. The finished designs have detailed design data that permit a quality release for parts modeling and manufacturing. Computer-aided manufacturing (CAM) is a companion technology that supports the fabrication of a wide variety of devices and mechanisms with favorable impact on scheduling, flexibility, quality, and costs. The principal users of CAD and CAM systems have integrated the essentials of both CAD and CAM into a single, central data base that contains complete repositories of pertinent design and manufacturing data from which their entire engineering and manufacturing operations are driven. The ability to build and test computer models of proposed designs without having to construct expensive and time-consuming hardware is extremely beneficial to industry. Currently evolving is a functional hierarchical extension, based on CAD/CAM, that progresses through Virtual Prototyping, Data Visualization, Visually Coupled Systems, and Virtual Reality Systems, elements that underpin sophisticated computer modeling and simulation.

Table 8.2-1. Computer-Aided Design and Computer-Aided Manufacturing (CAD/CAM) Militarily Critical Technology Parameters

TECHNOLOGY	Militarily Critical Parameters Minimum Level to Assure US Superiority	Critical Materials	Unique Test, Production, and Inspection Equipment	Unique Software and Parameters	Control Regimes
COMPUTER AIDED DESIGN (CAD)	Capable of assisting in the design of microcircuits with feature sizes less than 1 micron.	None identified	Specialized analysis software and test equipment for verifying that CAD designs conform exactly to the manufacturing requirement	Fully integrated CAD system with predictability of software process and product capable of yielding first pass parts of dense microcircuits with feature size less than 1 micron or CAD system with data capability of laying out complex physical structures.	WA IL Cat 2, 3, and 4
COMPUTER AIDED MANUFACTURING (CAM)	CAM tools, dimensional inspection or measuring systems with capability to control the manufacture of microcircuits with feature size less then 1 micron.	None identified	Computer driven machine and robotic tools capable of fabricating and testing equipment manufactured to militarily critical parameters	Unique tool driving software with capability to control the manufacture of advanced hardware.	WA IL Cat 2, 3 and 4
VIRTUAL PROTOTYPING	Extension of CAD design to the structure of military part models in the "virtual" manner for modeling and simulation using computers with CTPs > 1500 MTOPs.	None identified	None identified	Application specific software used in structuring computer based prototypes	WA IL Cat 4 WA ML 14
DATA VISUALIZATION	Process of converting a set of numbers resulting from militarily related complex numerical simulations or experiments into a graphical image, using computers with CTPs > 1500 MTOPs.	None identified	None identified	Large parallel processor software utilized in analyzing military based research data	WA IL Cat 4 WA ML 14

(Continued)

Table 8.2-1. Computer-Aided Design and Computer-Aided Manufacturing (CAD/CAM) Militarily Critical Technology Parameters (Continued)

TECHNOLOGY	Militarily Critical Parameters Minimum Level to Assure US Superiority	Critical Materials	Unique Test, Production, and Inspection Equipment	Unique Software and Parameters	Control Regimes
VISUALLY COUPLED SYSTEMS TO ACHIEVE USER IMMERSION	Field of vision 70 degrees vertical, > 120 degrees horizontal. Helmet sensing and tracking system; Miniature cathode ray tube with 25 micron line widths @ luminance levels above 2000 foot Lamberts	None identified	Miniature transducer winding, alignment and Helmholtz fixturing. Precision, nonferrous, automated mapping fixture.	Dynamic scattering and scene generation algorithms. Other display related algorithms	WA ML 14, 21
VIRTUAL REALITY SYSTEMS	Minimum of 10,000 polygons per frame at a frame rate of 30 Hz	None identified	Currently helmet mounted display and sensor equipment are key items but requirements are still unfolding as the technology matures	Application specific software for the manipulation of data bases representing over 1,000 designs each containing hundreds of parameters	WA IL Cat 4 WA ML 14

SECTION 8.3—HIGH-PERFORMANCE COMPUTING

OVERVIEW

High-performance computing encompasses conventional general-purpose digital computer processing equipment, including microprocessor-based single and multi-processor systems (including vector processors, array processors and other computers) and massively parallel and scalable computing. Also addressed in this section are graphic accelerators and image generators and programmable interconnections specially designed for aggregating high-performance processors to increase effective system power. Computers and software are explicitly identified as key technology areas in the DoD Technology Area Plans. High-performance computing is also critical to meet long-range S&T goals for battlefield digitization, human systems interfaces, manufacturing science and technology, and battlespace environment. High performance computing is an evolving technology for design of advanced military systems. (See also Section 8.2, CAD/CAM Technology.)

Table 8.3-1. High-Performance Computing Militarily Critical Technology Parameters

TECHNOLOGY	Militarily Critical Parameters Minimum Level to Assure US Superiority	Critical Materials	Unique Test, Production, and Inspection Equipment	Unique Software and Parameters	Control Regimes
GENERAL-PURPOSE DIGITAL PROCESSING EQUIPMENT, INCLUDING COMPUTERS, DIGITAL SIGNAL PROCESSORS, AND ARRAY/VECTOR PROCESSORS HAVING A COMPOSITE THEORETICAL PERFORMANCE	Exceeding 1500 million theoretical operations/second (Mtops)	None identified	None identified	Operational software for military systems with performance parameters and sensitive threat information	WA IL Cat 4 WA ML 17, 21
USAGE GENERATION AND ENHANCEMENT WRITING RATES GRAPHICS ACCELERATORS AND PROCESSORS	10 Million 3D vectors/second	None identified	High-resolution lithography (below 0.6 micron).	Image processing algorithms tailored for military C^4I^2 and data fusion, especially those incorporating ATR	WA IL Cat 4 WA ML 17, 21
INTERCONNECTION EQUIPMENT FOR AGGREGATING COMPUTATIONAL POWER	Having data transfer rates of > 80 Mbytes/second with aggregate throughput > 400 Mbytes	None identified	None identified	Operating systems specially designed for dynamic reconfiguration of computing clusters for specific military operations	WA IL Cat 4 WA ML 21
RADIATION HARDENING OF COMPUTER PROCESSING HARDWARE	Radiation hardened to withstand either of the following: - a total dose of 5×10^5 rads (si) or higher; or - a dose rate upset of 5×10^9 Rads (Si)/s or higher or - dose rate survivable $\geq 10^{12}$ Rad(Si)/s	None identified	Specially constructed facility to simulate the Electromagnetic Pulse characteristics	SEU and dose rate effects including SGEMP, software, analysis and simulation tools	WA IL Cat 4 WA ML 11
TEMPERATURE HARDENING OF COMPUTER PROCESSING HARDWARE	Designed to operate within the temperature range from 218 K (– 45 °C) to 397 K (+ 85 °C)	None identified	None identified	None identified	WA IL Cat 4 WA ML 11

SECTION 8.4—HUMAN SYSTEMS INTERFACE

OVERVIEW

Human systems interface, as covered in this subsection, encompasses all ways in which human operators interact with information systems. While the primary interfaces at present are visual output and manual input, the broader technology area also includes other forms of sensory inputs including auditory (voice and other audible indicators and warning), tactile, and haptic devices for both input and output. Human interface technology is being driven by a variety of requirements, ranging from those of the entertainment industry to the need to grasp and manipulate extremely large data sets in scientific research. For two-way communication, the state of the art remains mechanical (keyboard, joystick, etc.), which provides an input that is inherently unambiguous. Hands-off input devices (including eye-tracking, voice input) are being pursued as a way of dealing with increased workload, without increasing operator stress. Ultimately, the goal is to achieve total immersion of the operator in a virtual reality with which he or she interacts in a manner that is perceived as normal.

Table 8.4-1. Human Systems Interface Militarily Critical Technology Parameters

TECHNOLOGY	Militarily Critical Parameters Minimum Level to Assure US Superiority	Critical Materials	Unique Test, Production, and Inspection Equipment	Unique Software and Parameters	Control Regimes
VISUALLY-COUPLED DISPLAYS WITH RESOLUTION AND FIELD OF VIEW (FOV) DESIGNED TO MATCH HUMAN VISUAL PERFORMANCE	Better than: 2.5 Arc-minute resolution; Vertical FOV > 70°, and Horizontal FOV > 120°	None identified	None identified	Dynamic scene generation algorithms; Feedback algorithms for scene orientation and presentation; Smoothing algorithms for variable resolution, stereo displays	WA ML 17, 21
DYNAMIC SCENE GENERATION WITH REAL-TIME CAPABILITY	To sense line of sight and subject movement and generate appropriate scene with < 10 millisecond delay (>100 Hz refresh rate)	None identified	None identified	Characterization of dynamic scenes, texturing, etc.; information relating same to effectiveness of mission training	WA ML 17, 21
HAPTIC SENSORS	Force feedback in three dimensions, having 3 or more degrees of freedom	None identified	None identified	Software characterizing control responses of military systems	WA ML 17, 21

SECTION 8.5—INFORMATION SECURITY

OVERVIEW

This subsection covers Information Security technologies whose principal elements are cryptographic algorithms and cryptanalytic algorithms. These technologies are used by the U.S. military forces, certain U.S. Government (USG) departments and agencies, and authorized industrial users. Some special cryptographic systems are shared with U.S. treaty allies.

Table 8.5-1. Information Security Militarily Critical Technology Parameters

TECHNOLOGY	Militarily Critical Parameters Minimum Level to Assure US Superiority	Critical Materials	Unique Test, Production, and Inspection Equipment	Unique Software and Parameters	Control Regimes
CRYPTANALYTIC TECHNOLOGIES (FOR BREAKING CIPHERTEXT)	Due to the numerous variables required to implement an information security scheme and the wide range of products and services in which information security can be deployed this technology does not lend itself to specifically enumerated parameters.	None identified	Computers of 10,000 CTP, or greater, and software specially designed to test the ability of cryptanalytic systems to perform key searches, statistical, linear and differential cryptanalyses; and, factor 110 decimal digit, or larger, numbers.	Operating systems and applications for massively parallel cryptanalytic processors (> 16 processors) specially designed to perform statistical, linear and differential cryptanalyses, exhaustive key searches and quadratic and number field sieve factoring.	WA ML 11, 21 WA IL Cat 5
CRYPTOGRAPHIC TECHNOLOGIES (FOR KEEPING DATA SECURE)	Due to the numerous variables required to implement an information security scheme and the wide range of products and services in which information security can be deployed this technology does not lend itself to specifically enumerated parameters.	None identified	Computers of 10,000 CTP, or greater, and software specially designed to perform Randomness, Correlation, Weak Key and Symmetry Under Complementation tests to evaluate the strength of new USG encryption algorithms during development.	The software providing the cryptographic functionality must be specially designed and integrated into each application. The system engineering and integration, user system interface, algorithms and key generators must have zero defects.	WA ML 11, 21 WA IL Cat 5

SECTION 8.6—INTELLIGENT SYSTEMS

OVERVIEW

Intelligent systems encompass several hardware and software items whose ultimate objective is to build systems that autonomously adapt their functionality—without human operator intervention or preprogrammed logic constraints—in response to changing requirements and conditions. Intelligent systems can be implemented in software on general-purpose digital computers or on specially designed analog or hybrid analog/ digital neural networks and fuzzy logic chips. Interest continues in high-volume applications (such as in consumer products and appliances), particularly in the use of fuzzy logic/neural combinations wherein the training functionality of the neural net is used to optimize the fuzzy logic. Expert views of what constitutes machine or artificial intelligence have changed substantially in recent years, with advancing computer technology. Expert systems, once the predominant type of AI, no longer meet the basic criteria accepted for machine intelligence and are not considered by many experts to belong to the field of AI as it is now generally accepted.

Table 8.6-1. Intelligent Systems Militarily Critical Technology Parameters

TECHNOLOGY	Militarily Critical Parameters Minimum Level to Assure US Superiority	Critical Materials	Unique Test, Production, and Inspection Equipment	Unique Software and Parameters	Control Regimes
INTELLIGENT SYSTEMS	Ability to self modify and validate any two or more of the following, without expert/human intervention • Acceptable inputs/problem set • Rule logic, or statistical methods and clustering • Criteria • Outcomes	None identified	Neural networks exceeding 100,000 logical inferences/second	Military systems software revealing limitations vulnerabilities, tactics, etc., or threat characteristics. Encryption and digital signature techniques to ensure the validity and authorization of automated artificial intelligence functions (so-called "intelligent agents").	WA ML 17, 21 WA IL Cat 4
HIGH SPEED, LOW LATENCY SWITCHING DISTRIBUTED, INTELLIGENT SYSTEM	Data transfer rate (DTR) > 156 Mbits/second	None identified	Production equipment for development of optical, optical-digital hybrid equipment for communications	Network operating systems capable of automatic redistribution of machine intelligence function within a system to adapt optimally to new (not preprogrammed) conditions and requirements	WA IL Cat 5

SECTION 8.7—MODELING AND SIMULATION

OVERVIEW

Advanced simulation and modeling encompasses a wide range of dual-use applications, ranging from engineering design and manufacturing process optimization to dynamic flight trainers and simulators to distributed, interactive simulations of entire engagements and battles. The key elements of this technology involve digital processing to manipulate the data, human system interfaces through which the users interact with the data, and the knowledge embedded in the software discussed in related subsections of this MCTL (see Fig. 8.7-1 for cross-reference). The modeling and simulation technologies are particularly important in the context of engineering problems and manufacturing processes, where critical know-how is specific to applications not addressed here.

8.3	High Performance Computing
8.4	Human Systems Interface
8.5	Information Security
8.6	Intelligent Systems
8.8	Networks and Switching
8.10	Software
8.11	Transmission Systems

Figure 8.7-1. Primary Supporting Information Systems Technologies for Modeling and Simulation

Table 8.7-1. Modeling and Simulation Militarily Critical Technology Parameters

TECHNOLOGY	Militarily Critical Parameters Minimum Level to Assure US Superiority	Critical Materials	Unique Test, Production, and Inspection Equipment	Unique Software and Parameters	Control Regimes
GRAPHICS ACCELERATORS AND PROCESSORS WITH REAL-TIME VECTOR WRITING RATES	≥ 10 million 3D vectors/second	None identified	High-resolution lithography (below 0.6 micron).	Image processing algorithms tailored for military C^3I and data fusion, especially those incorporating ATR	WA IL Cat 4 WA ML 17, 21
SPEED AND RESPONSIVENESS OF DISTRIBUTED INTERACTIVE SIMULATION	Network speed > 623 Mbits/second Latency < 30 milliseconds	None identified	None identified	Real-time adaptive network operating systems. Applications data files incorporating doctrine, tactics, or force element/weapon characteristics.	WA IL Cat 4, 5 WA ML 17, 21

SECTION 8.8—NETWORKS AND SWITCHING

OVERVIEW

This subsection covers the militarily critical technology for telecommunication equipment used for the electronic transfer of information. It encompasses technologies for "stored-program-controlled" circuit and packet switching equipment and network routers used for establishing a communication channel between two or more points. Switches may be categorized as circuit, message, and packet or any combination thereof. The technologies found in information networking and network control are heavily dependent on the automation of the monitoring and controlling functions within the network. The monitoring and controlling functions are combined in separate systems, which are capable of working over a widely dispersed geographical area with equipment using various transmission media and switches using common channel signaling. These systems provide a centralized control capability to configure transmission equipment to optimize networks for loading and failures and to configure switches and routers to optimize the call distribution within a network. Technologies identified are optical switching, radiation hardened telecommunications equipment, and equipment capable of operating in extremely cold and hot temperatures. Related technologies are multi-level priority and pre-emption; dynamic adaptive routing; optical switching; and asynchronous transfer mode (ATM).

Table 8.8-1. Networks and Switching Militarily Critical Technology Parameters

TECHNOLOGY	Militarily Critical Parameters Minimum Level to Assure US Superiority	Critical Materials	Unique Test, Production, and Inspection Equipment	Unique Software and Parameters	Control Regimes
OPTICAL SWITCHING	Switching speed of 1.0 msec < 0.8 dB loss at wavelength of 1300 nanometers. Operates with either single or multimode optical fibers. Provides up to 4 port switch positions. Robustness to operate under shock condition of 1500 gs at 0–1000 Hz.	None identified	None identified	None identified	WA IL Cat 5
NETWORKING AND SWITCHING	Accommodate simultaneous access and transfer of scaleable and seamless variable speed information in a network operating between 16 Kbits/s and 10 Gbits/s	None identified	None identified	Real time software for ATM call control	WA IL Cat 5
TELECOMMUNICATIONS EQUIPMENT	Specially radiation hardened to withstand: total dose of 5×10^5 rads(si) or dose rate upset of 5×10^5 rads(si)/s or higher	None identified	Specially constructed facility to simulate the Electromagnetic Pulse characteristics with a field intensity of 50,000 volts/meter	None identified	WA IL Cat 5
TELECOMMUNICATIONS EQUIPMENT	Operating temperature from 218 K (– 55 °C) to 397 K (124 °C).	None identified	None identified	None identified	WA IL Cat 5

SECTION 8.9—SIGNAL PROCESSING

OVERVIEW

A signal is any physical quantity that varies with time, space, or any other independent variable or variables. Signal processing encompasses all aspects of conditioning, formatting, and extraction of useful information from such signals. Functions performed by signal processing include filtering to separate desired signals from undesired signals (noise) and analysis of the spatial or temporal characteristics of signals to extract information regarding the content of messages or the location and identification of targets. Image processing analysis and characterization of the spatial distribution of signals occur in two or more dimensions. The patterns generated may correlate to visual images or be entirely synthetic representations of nonvisual data from multiple sensors. Such 2D signal processing may or may not also include analysis of the temporal characteristics, such as moving target imagery.

Table 8.9-1. Signal Processing Militarily Critical Technology Parameters

TECHNOLOGY	Militarily Critical Parameters Minimum Level to Assure US Superiority	Critical Materials	Unique Test, Production, and Inspection Equipment	Unique Software and Parameters	Control Regimes
DIGITAL SIGNAL PROCESSING EQUIPMENT AT HIGH COMPOSITE THEORETICAL PERFORMANCE	1500 million theoretical operations/second (Mtops)	None identified	None identified	Signal processing algorithms for detection in noise and clutter; Image processing algorithms tailored for military C^4I^2 and data fusion, especially those incorporating ATR	WA IL Cat 4 WA ML 11, 17, 21
IMAGE PROCESSING SYSTEMS INTEGRATING ONE OR MORE SYSTEM SUPPORT FUNCTIONS	Integrate one or more of following system support functions: Automated electronic scanning and beam forming, Motion compensation and clutter/counter-measures rejection, Real-time feature extraction	None identified	Imagery displays, capable of 10 million 3D vectors per second or greater	Empirically validated criteria and algorithms for feature extraction, classification, and identification of military targets; Empirically validated techniques for processing degraded or partial images of military targets	WA ML 11, 17, 21
AUTOMATIC, REAL-TIME ACOUSTIC SIGNAL PROCESSING, SONAR	CTP = 1500 Mtops	None identified	None identified	Validated techniques for discriminating undersea noise, and localization algorithms accounting for undersea propagation effects	WA IL Cat 4, 6 WA ML 21
AUTOMATIC, REAL-TIME TERRESTRIAL ACOUSTIC PROCESSING	CTP = 1500 Mtops	Not applicable	None identified	Validated algorithms incorporating military target data and battle noise	WA ML 17, 21
AUTOMATIC REAL-TIME TARGET RECOGNITION	Specially designed to incorporate one or more empirically validated features for real-time detection and identification of military targets	None identified	None identified	Validated algorithms and detection criteria for military targets	WA ML 17, 21

(Continued)

Table 8.9-1. Signal Processing Militarily Critical Technology Parameters (Continued)

TECHNOLOGY	Militarily Critical Parameters Minimum Level to Assure US Superiority	Critical Materials	Unique Test, Production, and Inspection Equipment	Unique Software and Parameters	Control Regimes
ON BOARD-PROCESSING AND ANALYSIS OF COMPLEX SIGNATURES	Specially designed for capturing and analyzing complex dynamic (range > 100 dB) signals in real-time Able to withstand shock and accelerations to 300 g.	Special antenna radome and optical/IR window materials	Specially designed equipment for assembly of G-hardened components	Empirically-validated target detection algorithms, and target acquisition, aimpoint selection and firing criteria	WA ML 11, 17, 21

SECTION 8.10—SOFTWARE

OVERVIEW

Software consists of two components: (1) the *applications* matters, which contains algorithms, functions or logic, and parameters and (2) the *code*, which enables electronic computers to implement the applications. Militarily critical software applications are included in other sections of the MCTL as separate technology items or as "Unique Software and Parameters" in data tables. These applications use validated software that is generally related to one or more operational or developmental military systems. This subsection identifies the know-how that makes the second component, software code, militarily critical. There are two aspects to code: *product and process*. As product, code is considered militarily critical when it meets criteria in Table 8.10-1 under Military Critical Parameters. Process technologies in the development and life cycle support of software code—in such activities as configuration management, testing, metrics/measurement, integrated documentation, and architecture—involve technologies that are not currently militarily critical.

Table 8.10-1. Software Militarily Critical Technology Parameters

TECHNOLOGY	Militarily Critical Parameters Minimum Level to Assure US Superiority	Critical Materials	Unique Test, Production, and Inspection Equipment	Unique Software and Parameters	Control Regimes
SOFTWARE THAT ENABLES ELECTRONIC COMPUTERS TO IMPLEMENT APPLICATIONS	100% functional predictability High confidence > 99% High reliability ~ 100% Immunity < 1 error in 10^{12} External > cryptographic data integrity probability of error > 10^{-9} Internal-detect-fix < 1 operational cycle	None identified	Unique software tools for production, testing, and inspection needed to achieve the Militarily Critical Parameters.	Validated input data and military software provide the capabilities that make militarily critical systems superior	WA ML 17, 21 WA IL Cat 1–9

SECTION 8.11—TRANSMISSION SYSTEMS

OVERVIEW

This subsection covers the militarily critical technology for information transmission equipment and components used for transfer of voice, data, record, and other information by electromagnetic means either through atmospheric, exoatmospheric, or subsurface (water) media or via metallic or fiber optic cable. Information being exchanged is predominantly in digital form for voice, text, graphics, video and databases. This facilitates the application of security as required. The majority of the technologies for telecommunication transmission equipment are common to both military and civil systems. The information may be analog or digital, ranging in bandwidth from a single voice channel to video or multiple channels occupying hundreds of megahertz. Technologies identified as militarily critical include those for laser communications through atmospheric, exoatmospheric, and subsurface media or over optical fiber; radio transmission equipment operating at frequencies > 30 GHz with spread spectrum for low probability of intercept communications; phased array antennas for beam forming or nulling of interfering signals; and high-capacity, digitally controlled radio receivers. Other technologies considered were cable transmission technology for cables used where reduced vulnerability to intercept is of concern and underwater communications for concentrated naval operations. The types of cables considered are single or multiconductor, twisted pair or coaxial metallic cable, and those using optical fiber conductors. Cables can be employed on the surface for rapid deployment or buried in the earth for protection or as means of providing a required degree of hardness. Other applications are underwater inter-island or intercontinental connections. Technologies identified are those for single mode fibers with low dispersion; halide-based fibers of extremely low loss; and components and accessories for fiber.

Table 8.11-1. Transmission Systems Militarily Critical Technology Parameters

TECHNOLOGY	Militarily Critical Parameters Minimum Level to Assure US Superiority	Critical Materials	Unique Test, Production, and Inspection Equipment	Unique Software and Parameters	Control Regimes
OPTICAL INFORMATION TRANSMISSION	Using single mode optical fiber with dispersion < 0.12 ps/nm/km at 1520–1580 nm	None identified	Pulse degradation measurement	Intrusion detection techniques	WA IL Cat 5
LASER TRANSMISSION - FINE LINE	Linewidth < 300 MHz	None identified	None identified	None identified	WA IL Cat 5
RADIO EQUIPMENT	Frequency > 31 GHz	None identified	Semi conductor manufacturing technologies at higher frequencies	Frequency control and agility	WA IL Cat 5
RADIO EQUIPMENT - SPREAD SPECTRUM (FREQUENCY HOPPING)	User programmable spreading codes; total transmitted bandwidth > 100 times the bandwidth of any one information channel and > 50 kHz.	None identified	None identified	Spread spectrum necessary to detect and track hop rates and apply counter measures to deny use of the spectrum	WA IL Cat 5
RADIO RECEIVERS	Digitally controlled > 1000 channels: Automatic, search and scan Switching time < 1 ms.	None identified	Signal display and analyses equipment	Software with processors to cover and analyze the spectrum of interest	WA IL Cat 5
PHASED ARRAY ANTENNAE	Steering angle > 60 deg at frequency> 31 GHz.	None identified	None identified	None identified	WA IL Cat 5